Purpose: The purpose of this study is to describe the development and content validity of the Clinical Assessment of Body Alignment (CABA), to measure body alignment in children with cerebral palsy (CP).

Methods: Content validity and clinical utility were examined through expert opinion of 283 paediatric physiotherapists. Participants reviewed items as matching or not to the domain of body alignment. Items with >70% agreement were included.

Clinical utility evaluated on a 5-point scale. To assess the overall agreement of importance for clinical utility attributes, means and SD were calculated for each attribute. Fleiss' Kappa examined inter-rater reliability of expert responses.

Results: Percentage agreement (>70%) was high for 19 items and good for 1 item (>40%). Clinician's ratings showed overall fair to good agreement (k=.422). Four clinical utility attributes had a net importance score of >90%, although inter-rater reliability was low (κ = .21).

Conclusion: Content validity of the CABA was supported. Construct validity, reliability and responsiveness require further study.

What this adds to the evidence:

The CABA has potential to offer clinicians and researchers a clinically practical measure of postural alignment for children with CP.

Preliminary investigation of CABA shows good content validity. However, more studies to assess the assessments psychometrics including construct validity, reliability and responsiveness are required.

INTRODUCTION AND PURPOSE

The relationship between body alignment, postural control and motor development has been discussed in several research studies.[1-6] To accomplish efficient motor skill performance, postural control must be present and developed.[1] The efficiency and success of postural control and motor performance is related to an individual's ability to achieve body segment alignment [6]. In its absence a child's stability, efficiency, movement and function are impaired against gravity.[7] Given the importance of body alignment for functional movement in children with CP, a valid, reliable and clinically feasible assessment is important for describing when and how change in alignment occurs. A standardised approach should lead to improved clinical assessment of specific interventions, namely posture management programs.

Postural orientation is defined as the alignment of body segments (head, trunk, pelvis, arms, legs and feet) in relation to one another and with respect to the support surface, gravity and the environment.[8,9] Postural orientation can be an issue for some individuals with CP and therefore is of interest to health professionals.[10] Musculoskeletal issues such as joint range, muscle and soft tissue shortening, chest asymmetry, spine scoliosis and hip dislocation are commonly associated with poor postural alignment.[11,12] The development of postural deformities can result in movement and function being severely compromised.[12] Early identification and prevention of body alignment asymmetries from occurring at the outset, is a significantly important in the management of posture in children with CP.

Available standardised clinical assessments of body segment alignment for children with CP are limited. The Posture and Posture Ability Scale (PPAS) observes posture symmetry across body segments of trunk, head, pelvis, legs and arms in midline position.[13,14] Scoring is limited to yes/no responses to indicate a deviation from midline, with no demarcation of left or right

sides of the body. As such this limits the responsive of the assessment to changes in alignment and its accuracy in determining graded demarcation from midline and differences between left and right sides of the body. While other measures of alignment are sub-sections of developmental motor assessments such as The Chailey Levels of Ability (CLAS) [15] and the Seated Postural Control measure (SPCM).[16,17] Alternatively, other body alignment assessments such as the Spinal Alignment and Range of Motion Measure (SAROMM), [18] Goldsmith Indices [19] and Index of Windswept Deformity [20] focus specifically on one body segment rather than the whole body. A review of tests from the perspective of this research project cultivated the following conclusions.

Only 4 of the measures; PPAS,[13,14] SPCM,[16,17] SAROMM,[18] CLAS [15] demonstrated psychometric properties of reliability and/or validity. However, these measures demonstrated limitations in the scope of body positions assessed and ability to selectively identify changes in overall body posture asymmetry. Subsequently we did not identify a single measure that adequately examined whole body alignment in children with CP. Therefore, this study aimed to develop a tool to specifically address the need for a clinical measure to assess postural alignment.

Aims

This study set out to develop a tool to provide a clinically useful measure of postural alignment and to examine the content validity. Ethical approval was obtained from the Ethics Review Board of [redacted].

METHODS

Construction of the Clinical Assessment of Body Alignment (CABA)

An initial list of items was compiled by the primary researcher, with just over 15 year's clinical experience within paediatric physiotherapy. The items were based on the researchers' knowledge of posture and movement as well as their clinical experience and compared to items on the PPAS,[14] SPCM [17] and CLAS [15] to ensure no significant items were missed. No outstanding items were identified; it was noted that sections of the CABA were common to those in other assessments items (head, trunk, pelvis, arms, legs, feet), however the subsections of these sections where different in the CABA. A preliminary list of body segment items was collated and items expanded upon to cover all planes of movement across lying, sitting and standing; this created a detailed initial list of 56 items for the CABA (see Appendix 1).

The initial 56 items were reviewed by three researchers (physiotherapists with collectively over 40 years' experience in research and paediatric physiotherapy). Discussions were held among the researchers to reach consensus regarding: 1) how to reduce clinical and respondent burden by decreasing the number of items, 2) identification of technical item-construction flaws and bias, 3) how to improve item/test readability.

No items were removed; two items were added to enable differentiation between upper and lower leg position in sitting (Section E: leg – in sitting: flexion / extension upper leg and flexion/ extension lower leg). In a second revision, items scored on the right and left side (e.g. hip internal rotation) were combined into a single item with a separate score for each side. This decreased the number of items but captures asymmetries between sides of the body. This resulted in thirty-six items being combined; reducing the total number to 20 items (Table 1).

Study design

A non-experimental, cross sectional design was used to examine the content validity of the CABA

Participants

A purposeful sample of all members of the Association of Paediatric Chartered Physiotherapists (APCP), a special interest group within the field of paediatric physiotherapy, was undertaken.

Procedure

The revised CABA items were sent out electronically to APCP members. Participants where asked to contribute if they worked within the field of posture / postural management with children with CP. Respondents were asked to consider and score the 20 items in relation to relevance to body alignment. One open ended question was also provided for respondents to state any other item assessment that they felt should be included.

Respondents were also asked to consider and rate the importance of clinical utility attributes which they felt would assist assessments usability in clinical practice. As the CABA is intended to be a clinically based assessment, ensuring it aligned with crucial attributes was an important consideration in its development. They were asked to rate items that have been identified as supportive of the clinical efficiency of an assessment including: training (formal), cost, time to administer, format (paper vs. electronic or both), environments applicable to assessment use, ease of administration (equipment, therapist stress, demand on child), transportability of the assessment and ease of scoring analysis.

Within the instructions, the domain of interest, body alignment in children with CP, was clearly defined and the participants were provided with a structured framework for the matching of items.

Framework for matching items

The respondents were instructed to proceed through the assessment systematically. Respondents were given clear descriptions of the items to be considered for matching to the domain of body alignment. Each body segment to be assessed was clearly titled; each corresponding body alignment item relating to the specific body segment was outlined underneath the titled section. For example see Figure 1:

The CABA assessment items were rated as matching (yes / no) to the domain of body alignment. Clinical utility items were rated in terms of importance to the rater using a 5-point Likert scale (1=essential, 2= important, 3= acceptable, 4= marginally relevant, 5= not relevant). A common definition of importance was provided; essential (n=1) defined as item is essential and must be included to ensure the assessment has clinical utility. To exclude this would mean that the assessment had an extremely high risk of not being able to be used in everyday clinical settings. Not relevant (n=5) defined as this item would never impact on the assessment being used within everyday clinical practice.

Posture categorization

The CABA posture classifications used a 0-3 scoring system to rank the alignment with 0 indicating a position within 5 degrees, either side of optimal alignment, and three indicating the most significant deviation away from optimal alignment. All revised CABA items (Table 1) were based on this scoring system with the exception of three items (Items 15, 16 and 20).

Due to the limited joint range from optimal, which would result in narrow ranges within each score, these items were scored based on a 0-2 scale to minimise observer error. With the exception of 3 items (1, 4 and 7), all scoring was designed to differentiate the left and right of the body. Items 1, 4 and 7 are scored based on the direction of the movement.

Data analysis

Each participant was assigned a unique reference number and the questionnaire responses were extracted from Qualtrics into the IMB Statistical Package for the Social Science (SPSS version 25). Data analyses were conducted using IMB Statistical Package for the Social Science (SPSS version 25).

Characteristics of clinicians who returned partial versus complete questionnaires were analyzed using a chi-squared test. Matching items to the attribute of body alignment was quantified by calculating the percentage of agreement to each item. Items with a high agreement score (>70%) were judged to be a 'good match', indicating a strong agreement and representation the construct. To assess the overall agreement of importance for the identified clinical utility attributes, percentage agreement, means and SD were calculated for each attribute. Respondent inter-rater reliability was assessed using the Fleiss' Kappa statistic to measure the extent to which the different clinicians (raters) give the same responses to the rating questions.[21] The Fleiss Kappa is an extension of the more common Cohen's Kappa used in cases where there are multiple raters. The kappa statistic ranges from -1 to +1. A score of zero or less shows that there is no agreement between raters; scores greater than zero can be graded using the bands proposed by Fleiss,[21] 0.75 – 1.00 very good, 0.41 – 0.75 fair to good, < 0.40 poor.

RESULTS

Response:

In total, 2,196 physiotherapists were contacted. Participants were invited to contribute if they worked within the field of posture / postural management with children diagnosed with CP. Two hundred and eighty-three (283) questionnaires were returned for a response rate of 13%. Fourteen participants completed the screening element only; 185 partially completed the questionnaire and 84 respondents completed the full questionnaire. The descriptive data relating to respondents characteristics (N=283) were collectively analysed and grouped by region, years of experience, place of work and area of speciality.

Respondents came from all 4 nations of the UK and from all regions of England. Over half of respondents, 54%, had been in the profession for 20 years or more. The majority, 83%, worked in the NHS with 9% in private practice and 8% in education. Three quarters, 76%, worked in neurodisability and 54% worked in the community. Fifty-eight per cent of respondents worked in multiple areas of the 8 listed specialties.

Content validity (item agreement)

The level of agreement amongst clinicians regarding item affiliation to body alignment was calculated using percentage agreement (Table 2). The proportion of respondents who indicated that the 20 CABA items matched body alignment varied from a low of 65% for leg internal/external rotation to high of 94% for head flexion/extension.

Among the participating clinicians, all items, except number 14, were identified as a highly related to body alignment with an agreement level of greater than 70%. Item 14 (leg internal/external) was the only item below with an agreement of 65%. In 14 out of the 20

items the agreement was >80%, indicating a consensus that these items strongly relate to the construct of body alignment.

In 15 of the CABA items the 95% CI lower range was >70%. Four of the CABA (items 3, 6, 12, 19) showed a 95% CI >65% and one item (14) >55%. The CI values of item 1 (head flexion/extension) were greater than CI values for item 14, indicating that clinicians felt item 1 was a better indicator of body alignment than item 14 (leg internal/external). No additional items were reported frequently from the open ended question (N=13 responses). Of these, 4 responses related to body linkages, whilst others responses (N=7) related to a broad range of issues not directly related to body position such as; environmental, muscle tone and task demand.

Respondent inter-rater reliability

Fleiss' Kappa was used to assess inter-rater reliability among respondents and the results showed moderate agreement (K = .422, 95% CI, .33 to .51, $p < .005$). In addition, inter-rater reliability was also assessed within clinician subgroups (based on years of experience and workplace description) (See Table 3).

Agreement between raters was higher for those who have been in the profession for more than 20 years compared to those with fewer years served. Agreement was higher amongst non-NHS clinicians (those in private practice or education) and for those who do not work in the community.

Clinical Utility

For the clinical utility attributes, the respondents were asked to rate are listed in Table 4. This table also presents the combined totals of essential/important scores for each attribute,

percentage agreement among respondents and the mean scores and standard deviation for each attribute. The ratings were based on a 5 point Likert scale; a score of one indicated a rating of essential/important., while a score of 5 indicated not relevant.

The rating of essential was highest (76%) for 'overall ease of use' with 'time to complete', 'usable in different environments' and 'ease of analysis' rated as essential by greater than 50% of the respondents. Format (paper vs. electronic or both) was least important, receiving a rating of essential from only 20% of the respondents.

The total combined essential ratings ranged from a low of 35% (format paper) to 98% (ease of use) (See Table 4). The rating of essential was highest (76%) for 'overall ease of use' with 'time to complete', 'usable in different environments' and 'ease of analysis' rated as essential by greater than 50% of the respondents. Format (paper vs. electronic or both) was least important, receiving a rating of essential from only 20% of the respondents. Four attributes had a combined score >90%; ease of use, time to complete, ease of analysis and usable in different environments. The greatest variation is noted in the attribute 'requirement of equipment'. Ease of use has the smallest variation. There is no significant level of agreement between the respondents' rating levels (Fleiss' Kappa K = .21 95% CI, .11 to .31, $p < .005$).

DISCUSSION

Content validity (item agreement)

Content validity for the CABA item development was supported by the high percentage agreement of items matching the construct of body alignment. The level of agreement amongst clinicians regarding item affiliation to body alignment was calculated using

percentage agreement along with 95% confidence intervals (Table 2). The 95% CI indicate that while all items, except one (Item 14), were highly representative of body alignment, there were differences in the magnitude of agreement between individual items. While four of the CABA items (items 3, 6, 12, 19) had a lower 95% CI range score below 70%, overall the agreement percentage by respondents was high, signifying that these items matched the domain of body alignment.

The lowest agreement was within one item (item 14: Leg internal/external), which scored a lower percentage agreement (65.1%) and 95% CI range (55%, 75%) compared to the rest of the items. The reason for this is unclear; this discrepancy could be attributed to the movement direction being assessed by this item when set in the context of clinical assessment of body alignment. However, the movement direction analysed by this item has important implications to overall body alignment with previous research having established a relationship between hip position and alteration in postural orientation,[1, 2] Given that the percentage agreement was close to the threshold of 70%, the decision was made not to exclude item 14 from the assessment.

We suggest that this supports 19 of the 20 CABA items as highly representative of the construct of body alignment measurement, whilst 1 item is moderately representative. Content validity often involves subject matter experts evaluating the degree to which test items match the test specifications domain.[22] Most studies investigating psychometric properties of body alignment measurements have utilised expert opinion in their test construction process. [14,15,17,23] The existing accounts on test construction give a brief description of development with little published data to allow quantifiable analysis on expert

level of agreement in relation to test items and their construct. As such, comparison of item relevance and validity cannot be made between published research and those of this study.

Respondent inter-rater reliability

Inter-rater reliability between respondents was fair to good (κ = .422) in matching CABA items to the domain of body alignment. A higher agreement was seen in those with >20 years clinical experience. This could be a reflection that the highest percentage of respondents to this study had >20 years' experience (n=88). Posture and body alignment in children with CP is a post graduate skill, therefore clinicians working in this field and area are likely to have more than less experience in the assessment of body alignment.

In addition, there was higher agreement reliability between respondents who are non-NHS clinicians, those working in private practice or education (k= 0.53) compared to those who work in the NHS (k= 0.40). No specific reports could be found on specific areas of clinical work and working environment. Therefore, it could be speculated, that non-NHS clinicians are more likely to work frequently within specialist areas such as postural management, compared to those who work in the NHS. Results from this study suggest that this hypothesis could be substantiated.

Clinical Utility

Clinical utility refers to how applicable an assessment is within clinical settings.[22] It relates to attributes which influence functionality and usefulness of an assessment, such as time and ease of use.[22] The time it takes it administers an assessment and complexity of completing may determine how usable an assessment is within day to day assessments. The longer and more complex an assessment takes, the less likely it is to be selected by therapists within

day to day clinical practice. Four attributes relating to the clinical utility of clinical assessments had a net importance score of >90%, between respondents, indicating they are significant to assessments functionality within clinical practice. These attributes were ease of use, time to complete, ease of analysis and usable in different environments. This is not surprising, given that assessments like the CABA may need to be applied in a variety of settings with multiple individuals. Failure to recognise critical components of a measures clinical utility, such as cost and application, can result in the measurement being impracticable within the clinical environment.[24] To date, this area has received scant attention in research literature investigating body alignment measurements, with existing studies omitting recognition and discussion on the practicalities of clinical application. Although the level of agreement between respondents was low, we propose that the CABA, as a clinically usable tool, needs to align with the utility attributes identified as being important in order to be applicable and accessible to clinicians.

Benefits of the CABA

The CABA construction has shown a high level of content validity to the domain of body alignment with high level of agreement and good reliability in response from experts within the field of CP and posture. The CABA has been developed as an easy, inexpensive and low-burden way to measure postural alignment in children with CP. To our knowledge there are no other clinical measures for children with CP that demonstrate detailed content validity and item construction to assess total body segment alignment across any postural position while also allowing differentiation between left and right sides of the body. Current assessments, such as the PPAS,[13,14] have only focused on one of these elements. This study has shown the CABA encompasses important components of body alignment assessment.

With 19 items matched to a high level of agreement to assess body alignment across sitting, standing and lying positions, the CABA allows degrees in postural mis-alignment to be measured and demarcation between sides of the body to be clinically assessed. As the intent of the CABA is to succinctly measure overall body alignment, it cannot be broken down into subscales associated with aspects of postural control e.g. Trunk stability, but should have a direct implementation on therapy interventions.

Limitations of the CABA

Within this study we acknowledge that assumptions were made in developing the assessment, these include therapists would understand and be familiar with the terminology and posture categorisation in use, and the sample size used to validate this was small.

The response rate of 13% could be viewed as low, however this was not unexpected. The APCP covers a wide field of expertise across paediatrics, inclusive of CP and it is highly likely that some members have limited or no involvement with CP or posture as part of their practice and therefore would not have responded to the study request. Currently the CABA only demonstrates content validity, further psychometric properties require investigation. Future studies examining construct validity of the CABA against a sample of children with CP of various functional abilities, would determine whether the items represent a valid construct to that of CP. Reliability, both inter- and intra-rater, of the CABA use with clinicians also needs to be completed. An examination of the CABA's responsiveness and sensitivity to change in children with CP after posture management interventions focusing on improving postural alignment would be beneficial prior to the assessment being used as an outcome measure. At present how to interpret the CABA raw scores is unknown and additional studies in typically developing children and those will CP are needed to develop scoring cut-

offs and norms for this scale. This will be explored in further investigations as part of the development process of this assessment. Finally, research on the measure in children with other medical diagnoses to neurological disabilities is warranted. The analysis of the construct validity, reliability and responsiveness in children with CP is in progress.

CONCLUSION

Preliminary investigation of this new assessment of posture and alignment is promising. The first steps of identifying valid items to include in the assessment of total body alignment have been taken and content validity and clinical utility have been explored. Further studies to assess the psychometrics of CABA, including construct validity reliability and responsiveness, should be undertaken.

The CABA has potential to provide clinicians and researchers with a viable and practical measure of postural alignment for children with CP. Content validity of the CABA is supported for the domain of body alignment in CP children. Further research examining construct validity against all GMFCS levels of CP children, inter-rater and intra-rater reliability and responsiveness to change in postural alignment of the CABA in the context of effective interventions is already being undertaken. This research is needed prior to use of the CABA as an evaluative measure in clinical practice.

What this adds to the evidence:

The CABA has potential to offer clinicians and researchers a clinically practicable measure of postural alignment for children with CP.

The development of a measurement tool to assess total body alignment in children with CP will expand the options for physical therapists document baseline posture and reassess changes following surgical or therapeutic interventions.

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Figure Legend:

Figure 1: Item example